High intensity protons in RHIC

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Radiation safety

D. Beavis, E. Lessard

- Accelerator Safety Envelope (ASE) limits intensity to 2.4e13 protons per beam, at 250 GeV
- At 3e11 protons/bunch, this corresponds to 80 bunches/beam
- To transfer bunches with 3e11 into RHIC, Thompson Road needs to be closed
- Detailed study plan has to be reviewed and approved by RSC to exceed ASE limit temporarily

Scrubbing

M. Blaskiewicz, CM

- Latest scrubbing efforts in Run-9 were hampered by radiation-induced false fire alarms in IR 10

- Walk-through with fire protection engineer and fire/rescue: Area is protected by sprinklers, which will go off due to heat. Smoke detectors can be temporarily disabled during scrubbing.

- Rebucket high-intensity bunches at injection into 197 MHz bucket

- 1 - 2 days (not APEX)

Beam dump

L. Ahrens, K. Yip, CM

- Beam dump was upgraded for Run-11 to avoid quenches of downstream magnets (sleeves in beam pipe)
- According to simulations, no more quenches to be expected for bunch intensities up to $\approx$ 2.5e11
- BLMs will be installed in a location that is relevant for those quench-causing losses
- Have to make sure during operations that these BLMs don't saturate

- Stronger kicks expected to reduce the losses at the magnets, since beam is kicked deeper into the dump

- However, for FY-12, kick will likely be reduced by 20 percent to reduce the risk of pre-firing

- If reduced kick does not result in magnet quenches at regular intensity, we have a margin for higher intensity by just restoring the regular kick strength

- APEX: Study dependence of losses on kick strength in detail

Impedance

M. Blaskiewicz, M. Minty, CM

- $Z_\perp$ was measured at $3-5\,\mathrm{M}\Omega/\mathrm{m}$ in 2002. Last year, Rama reported $18\,\mathrm{M}\Omega/\mathrm{m}$
- Measure tune of bunches with different intensities, using BTF/BBQ
- Since $\Delta Q \propto Z_\perp/(\sigma_z E)$, short bunches at injection energy give best resolution
- Required tune resolution: few 1e-4

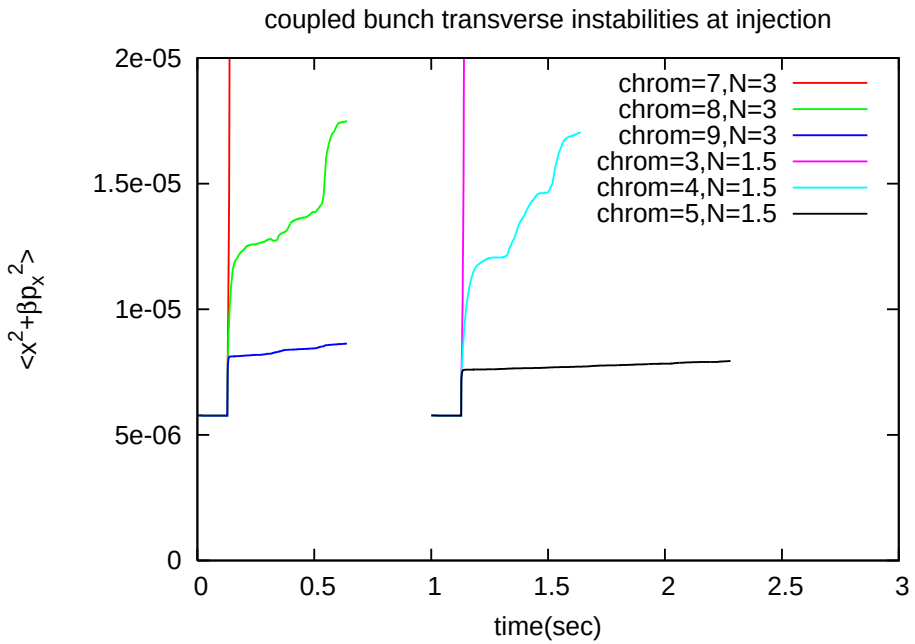
Instabilities

M. Blaskiewicz, CM

- Simulations of coherent instabilities at injection
  - transverse impedance:
    - space charge (direct and image currents)
    - resistive wall
    - BPMs, abort kicker, and unshielded bellows
  - longitudinal impedance: broadband, yielding correct $|Z/n|$

Simulation results for coherent instabilities at injection

14 ns FWHM bunch length



Injection situation expected to be worst due to low synchrotron frequency (5 Hz) and small γ

Benchmark this by lowering chromaticity at injection until beam becomes unstable

Electron cloud

SY Zhang, CM

- Electron cloud induced dynamic pressure rise may cause emittance growth below instability threshold (Zhang and Ptitsyn, PRST-AB 11, 051001 (2008))

- Threshold has apparently increased over the years (scrubbing?), from 1.3e11 in Run-6 to $\geq$ 2e11 in Run-11.

- Measure emittance growth at injection in correlation with dynamic pressure rise and electron cloud, with 80$\times$3e11 in 120 bunch pattern (ASE limit)

RF beam loading

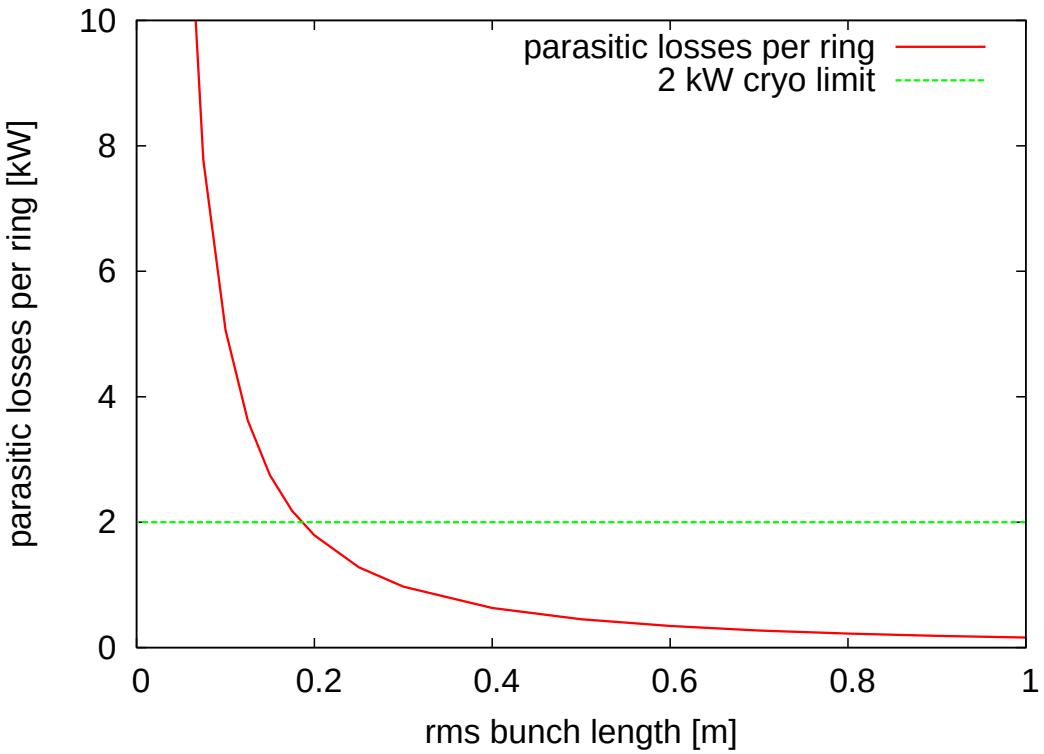
M. Blaskiewicz, M. Brennan, A. Zaltsman, CM

- Beam loading of the 28 MHz system during rebucketing from 9 to 28 MHz may be a concern

- Still working on a detailed study plan that's consistent with ASE limits

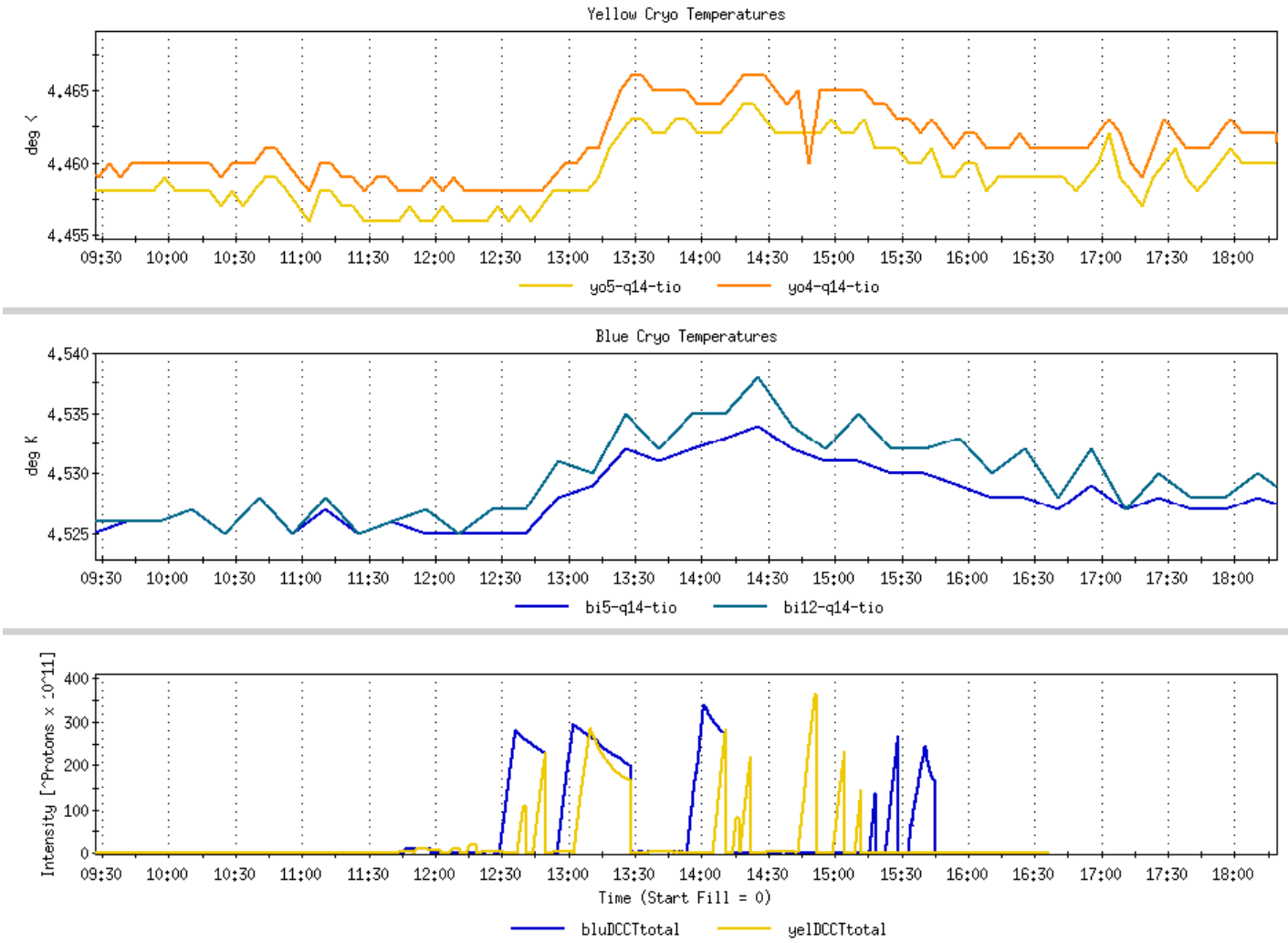
Resistive wall heating

M. Blaskiewicz, P. Thieberger, CM



At 3e11/bunch need to limit bunch length to $\sigma_s \geq 20\,\mathrm{cm}$
Measure cryo load and He temperature with high intensity and short bunches

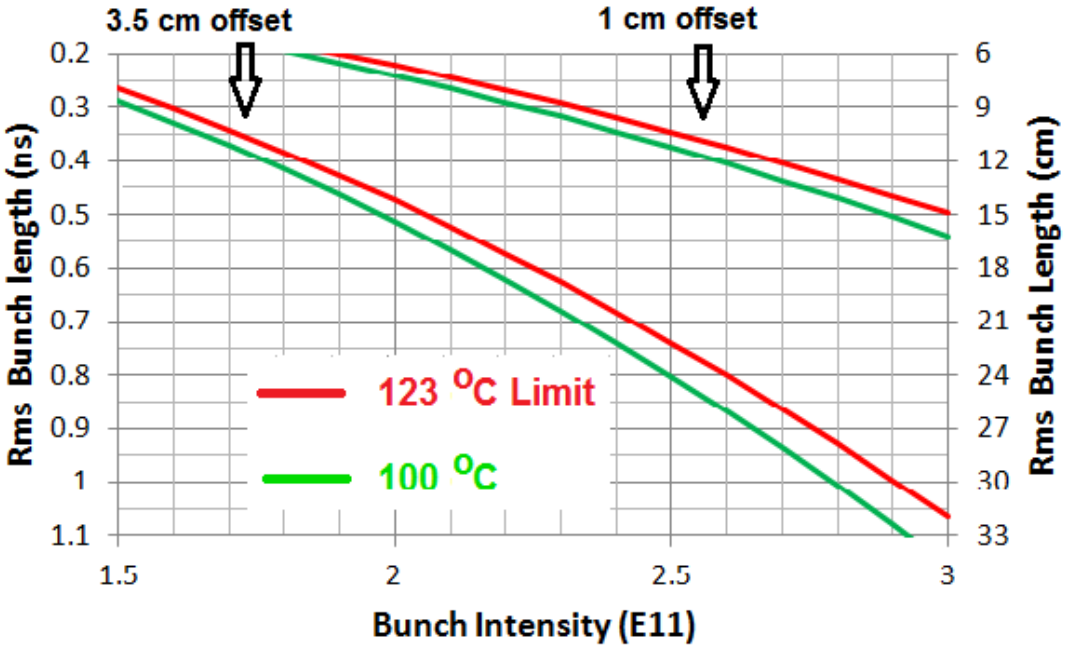
Cryo temperatures during scrubbing in Run-9



BPM cables

P. Thieberger, M. Minty, CM

Preliminary estimates of RHIC operational limits due to cryogenic BPM cable heating (specified maximum 123 degrees C).



- 3.5 cm orbit offset is limited by beam pipe radius; 1 cm maximum offset requires orbit interlock system

- Using orbit feedback maximum offsets below a millimeter are routinely achieved. Need interlock for accidents.

APEX: Some BPM cables will have thermocouples attached for testing. Measure temperature as function of displacement, bunch length, and intensity.

Summary

- Details of many studies are still being worked out
- Some studies may be combined once details are known
- If present ASE is exceeded, need review and approval by RSC
- Since Thompson Road needs to be closed for 3e11 protons/bunch transfer, high intensity studies should be scheduled for as few days as possible to minimize impact on traffic